charts were made, how the skills to make them were learned, and how charts can be related to the expanding worlds of commerce and power. Unlike *mappaemundi,* Portolan charts functioned within concrete social and economic conditions in which accuracy mattered. In a brilliant and fascinating section, Campbell shows how place names on charts can be studied to date them. Toponymy was a major feature of Portolan charts; small charts did not, as a rule, have fewer names than large ones, and toponymic content was revised continuously. Other aspects of accuracy studied by Campbell include projection, the role of the compass, and units of measurement. Because Campbell has studied Portolan charts so thoroughly, he has realized the need for a stylistic index of common and distinguishing characteristics of them. His chapter also ends with a list of charts, which has references to readily available illustrations in print.

By comparison with the chapters on *mappaemundi* and Portolan charts, Harvey's chapter on local and regional plans is short. But such maps were in fact relatively unimportant in medieval life, Harvey explains, because written texts predominated over graphic representations in descriptions of property divisions, travelers' routes, and the like. Clearly, the lack of such maps does not indicate that medieval people were uninterested in space, but rather that they could meet their needs to understand space on this level without maps. What maps existed lacked scale; they functioned as pictorial displays, with oblique or perspective views. How can the emergence of scale maps and of maps with accurate geographical outlines be explained, asks Harvey, and what have such maps to do with a medieval interest in scientific geography?

In their conclusion to Volume I, Woodward and Harley reemphasize the role of social forces. The evolution of maps, they argue, "can be made sense of as a historical process only when seen as part of the totality of a society's knowledge and when that knowledge is also seen as a manifestation of a socially constructed world" (p. 506). As they carry the history of cartography forward, we will learn much not only about maps, but about how and why and with what consequences civilizations have apprehended, expanded, and utilized the potential of maps. Few scholars are ever privileged to participate in a venture that promises to transform an entire field of knowledge. The world of scholarship is indebted to Brian Harley, David Woodward, and their collaborators in *The History of Cartography*.

JOSEF W. KONVITZ

Department of History
Michigan State University
East Lansing, Michigan 48824

Out of control

James R. Beniger. *The Control Revolution: Technological and Economic Origins of the Information Society*. x + 493 pp., illus., bibl., index. Cambridge, Mass./ London: Harvard University Press, 1986. $25.

Historians have long looked to the social sciences for help in making sense of the past. And with good reason. Social scientists have devised concepts and approaches that have proved invaluable for historical inquiry. Social science poses new questions. It frees historians from the partisanship of contemporaries and the conventions of historiography.

Even more important, the social sciences provide historians with organizing

themes. Historians have traditionally been long on data and short on ideas. Yet in recent decades this familiar situation has been enormously aggravated. The computer, microfilm, and the Xerox machine have dramatically expanded historians' ability to process information. But just what one does with all this information is by no means clear. Confronted with reams of printouts and bulging filing cabinets, historians have borrowed from the social sciences the plot lines and dramatic scaffolding they need to make sense of their data.

James R. Beniger's *The Control Revolution: Technological and Economic Origins of the Information Society* is in this distinguished social science tradition. Beniger, a sociologist at the Annenberg School of Communications at the University of Southern California, has written a book that is bold, even audacious. He seeks nothing less than to reconceptualize the history of the modern era and the language of the social sciences in terms of information processing, control, and communications.

Beniger begins with a pair of related questions. Why has information come to dominate the world's largest and most advanced economies? And why has it "only *recently* emerged as a distinct and critical commodity" (p. vi)?

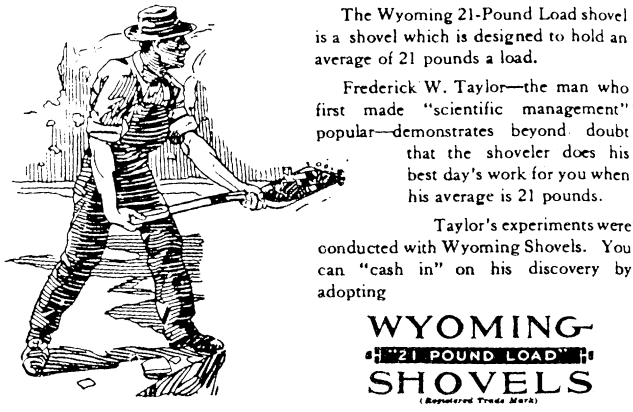
His answer is the "Control Revolution." Using the United States as his test case, he posits a late nineteenth-century revolution in the organization of the economy, based on the establishment of bureaucratic structures in business and government. This revolution resolved the "crisis in control" caused by the unprecedented speeding up of material processing made possible by steam power. Beniger dates the American Industrial Revolution from this crisis, which he identifies with the construction of a railroad network in the 1840s (p. 207).[1] For both revolutions, speed is the central parameter (pp. 175, 207).

Bureaucracy resolved the crisis by restoring, albeit with "increasing centralization," the economic and political control that had been lost at more local levels of society during the Industrial Revolution (p. 7). It did so by harnessing speed. Bureaucracy, in short, is a *technology,* defined not "in the narrow sense of practical or applied science but in the more general sense of any intentional extension of a natural process" (p. 9).[2] It is, in fact, "the most important control technology" to emerge before the coming of the computer (p. 6). Control—that is, "purposive influence toward a predetermined goal"—can be augmented either by increasing an institution's capacity to process information or by decreasing the amount of information to be processed. Bureaucracy, computers, and, most recently, microprocessors do the former (p. 7). Preprocessors do the latter—destroying or ignoring information "in order to facilitate its processing" (p. 15).

The transformation of the material economy is but one consequence of the Control Revolution. It has also had a "pervasive" impact on cultural and intellec-

[1] Beniger's identification of the Industrial Revolution with the coming of the railroad is clearly indebted to Alfred Chandler, Jr., *The Visible Hand: The Managerial Revolution in American Business* (Cambridge, Mass.: Harvard Univ. Press, 1977). Yet it is worth noting that the identification is Beniger's and not Chandler's; "industrial revolution" (lowercased) appears but once in *The Visible Hand*'s index, referring to developments in eighteenth-century Great Britain. Thomas Cochran, in contrast, contends in *Frontiers of Change: Early Industrialism in America* (New York: Oxford Univ. Press, 1981), that the "revolutionary phase" of American industrialism ended by 1825 (p. 78). Brooke Hindle and Steven Lubar reach a similar conclusion in *Engines of Change: The American Industrial Revolution, 1790–1860* (Washington, D.C.: Smithsonian Institution Press, 1986), pp. 23–26. To confuse matters further, Robert Wiebe puts the "industrial revolution" (lowercased) *after* the Civil War in *The Opening of American Society: From the Adoption of the Constitution to the Eve of Disunion* (New York: Knopf, 1984), p. 252. Little wonder that Gordon Wood was moved to remark, in his 1987 presidential address before the Society for Historians of the Early American Republic, that the concept had lost its utility and should be dropped from the historians' lexicon.

[2] Even the brain itself qualifies as a human technology, since it "probably developed in interaction with purposive tool use" (p. 9).



Detail of an advertisement from Engineering and Mining Journal *for a line of shovels based on Frederick Winslow Taylor's study of shoveling at Bethlehem Steel. From* The Control Revolution.

tual life (p. vi). For natural scientists, it helped to "reconceptualize traditional subjects like cellular biology" (p. 57). For social scientists, it created the very language to which "we . . . may hope to reduce our proliferating but still largely unsystematic knowledge of social structure and process." Information processing, control, and communications are central to "all aspects of human society and social behavior" (p. 436). Yet before the Control Revolution this insight would have been impossible: "Most of the conceptual apparatus we need to understand the Control Revolution . . . was directly inspired by the Control Revolution itself. . . . The new ideas followed major technological advances. . . . This means that, although our interest here lies primarily in understanding the Control Revolution, we can also chronicle its impact on the history of ideas. . . . For those who consider intellectual history to have a material basis, we could hardly do otherwise" (p. 39).

Beniger is at his best when he describes how new forms of energy transformed the nineteenth-century American economy. He draws imaginatively on the relevant secondary literature, though curiously Thomas Cochran's *Frontiers of Change* and Robert Wiebe's *Search for Order* are missing from the bibliography. And while Thomas Hughes's *Networks of Power* is in the bibliography, his concept of "reverse salients," which invites comparison with Beniger's "crisis of control," goes unmentioned in the text. In contrast, the enormous debt Beniger owes Alfred D. Chandler's compelling analysis of the making of the modern corporation is evident on virtually every page. Large stretches of *The Control Revolution,* in fact, can be read as a sympathetic gloss, from the perspective of information theory, on *The Visible Hand.*[3]

Beniger's analysis is not without its problems. He is quite right to stress the importance of the eighteenth-century commercial revolution that preceded the railroad, but slights its cultural preconditions and its close relationship with the emergence of the nation-state.[4] Even more surprising, given Beniger's theme, is his cursory treatment of the invention of printing. Elizabeth Eisenstein's *Printing*

[3] Cochran, *Frontiers of Change* (cit. n. 1); Robert H. Wiebe, *The Search for Order, 1877–1920* (New York: Hill & Wang, 1967); Thomas P. Hughes, *Networks of Power: Electrification in Western Society, 1880–1930* (Baltimore: Johns Hopkins Univ. Press, 1983); and Chandler, *Visible Hand* (cit. n. 1).

[4] For recent discussions of these developments see Cochran, *Frontiers of Change;* and Hindle and Lubar, *Engines of Change* (cit. n. 1).

Press as an Agent of Change provides the sociologist with a wealth of insight into the critical "control revolution" that ushered in the modern era, but Beniger chooses not to follow her lead.[5]

On a more mundane level, specialists will inevitably find much to quarrel with. To cite but one example, Beniger's discussion of the coevolution of the railroad and the telegraph oversimplifies a complicated story and is simply wrong for the period before 1850 (pp. 17, 230). Likewise, the various lists he uses to schematize his argument include various factual errors and questionable assumptions. Yet Beniger has not set out to write a monograph, and he should hardly be faulted for making occasional misstatements on a topic that historians have so notoriously neglected. *Caveat emptor.*

More troubling is Beniger's opening section. Here he sets out to demonstrate the centrality of information processing, control, and communications to the origins of life, as well as to all of human history prior to the mid eighteenth century. In a manner reminiscent of those celebrated general education courses that earnestly aspire to cram everything you would ever want to know about anything into twelve short weeks, Beniger takes his reader on a whirlwind tour of planet Earth, beginning with the amoeba, including an appendix on "What is Life? An Information Perspective." Even the most provincial of historians of the modern period may find this foreshortening a bit unsettling. Does the commercial revolution deserve the same space (approximately a hundred pages) as all previous history, prehistory, and human evolution put together? Is this not technological determinism with a vengeance?

Beniger would no doubt find these questions somewhat beside the point. As he is quick to point out, the full importance of information in contemporary society cannot be understood by *any* exercise of the historical imagination: "History alone cannot explain why it is information that increasingly plays the crucial role in economy and society" (p. vi). "Historical detail can only obscure the more fundamental laws that govern energy conversion and material processing" (p. 31). "Here, then, is the most fundamental reason why the Control Revolution has been so profound in its impact on human society: it transformed no less than the essential life function itself. . . . We would have to go back at least to the emergence of the vertebrate brain if not to the first replicating molecules—marking the origin of life on earth—to find a leap in the capability to process information comparable to the Control Revolution" (p. 36). Heady stuff indeed. But not much use to historians preoccupied with less cosmic concerns.

Yet Beniger does provide historians a clue as to how his work might be assimilated. The clue is the concept of "telenomy," which he borrows from the biologists Colin Pittendrigh, Julian Huxley, and Ernst Mayr. As Beniger explains, telenomic processes are goal-directed but not teleological. That is, they owe their direction not to some future outcome but to a prior program. This program, in turn, must exist in "a *physical* form, thereby eliminating vitalist and other metaphysical baggage" (pp. 40–41).

Modern historians, and even some twentieth-century specialists, have often neglected these processes. Yet they are eminently recoverable, embedded in sources ranging from organization charts and complex algorithms to congressional debates over the federal budget. Only by ferreting them out will historians be able to understand the large-scale institutions that have become such prominent

[5] Elizabeth L. Eisenstein, *The Printing Press as an Agent of Change: Communications and Cultural Transformations in Early-Modern Europe,* 2 vols. (New York: Cambridge Univ. Press, 1979). See also Walter J. Ong, *Orality and Literacy: The Technologizing of the Word* (London: Methuen, 1982). Beniger also neglects the work of the great Canadian economic historian Harold Innis, an omission that is especially curious given their shared preoccupation with the material basis of information technologies; see esp. Innis, *Bias of Communication* (Toronto: Univ. Toronto Press, 1951).

actors in the contemporary world. For this insight alone, *The Control Revolution* makes a major contribution to the "organizational" approach to the American past.[6]

Much more problematic is Beniger's effort to recast the social sciences as a branch of information theory. This seems unlikely. As Daniel Bell has brilliantly argued in *Cultural Contradictions of Capitalism,* society is not a system.[7] Changes in the realms of culture and politics do not necessarily follow, or even parallel, changes in the technoeconomic realm. Did the Control Revolution spur the reconceptualization of cellular biology? Perhaps. But even the most dogmatic of externalists would be quick to add qualifications that Beniger's theory fails to supply.

The limitations of Beniger's theory are highlighted by his treatment of popular fears regarding technology: "To understand the basis of human society in information processing, communication, and control . . . is to appreciate the profound irony in popular sentiment against technology that has persisted over the past century. . . . No human technology has more in common with all living things than do our various capabilities to process information, whether they be institutionalized in the formal structures and procedures of bureaucracy, input electronically to computer memory, or photolithographed into the silicon wafers of microprocessors" (pp. 59–60). But are these fears really so surprising, given the cultural traditions that inform modern American sensibilities? And in an age haunted by the specter of nuclear war and environmental catastrophe, are they unnatural?

Even more serious is the theory's silence with respect to the politics of control. The Control Revolution, unlike the Managerial Revolution or the Industrial Revolution, does not lend itself to prosopography. To put the matter bluntly, precisely who is doing what to whom? The Industrial Revolution gave us industrialists; the Managerial Revolution managers. To whom do we owe the Control Revolution? Controllers? To trace its genealogy to the amoeba begs every interesting historical question.[8] For this reason alone, it seems improbable that Control Revolution will be finding its way into history textbooks as an organizing theme. The issues are unquestionably important, and Beniger asks the right questions, but for adequate answers we must await a more sensitive discussion of the cultural and political dimensions of the information age.

RICHARD R. JOHN, JR.

History and Literature
Harvard University
Cambridge, Massachusetts 02138

[6] For a recent assessment of the "organizational synthesis" see Louis Galambos, "Technology, Political Economy, and Professionalization: Central Themes of the Organizational Synthesis," *Business History Review,* 1983, *57*:471–493. For a useful critique see Alan Brinkley, "Writing the History of Contemporary America: Dilemmas and Challenges," *Daedalus,* 1984, *113*:132–134.

[7] Daniel Bell, *The Cultural Contradictions of Capitalism* (New York: Basic, 1976); and Bell, *The Coming of Post-Industrial Society: A Venture in Social Forecasting* (New York: Basic, 1976).

[8] Bell, *Post–Industrial Society,* pp. 269–298, 341–367.